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ERCB

LODGEPOLE Blowout Report

Summary and Recommendations for Report D84-9

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LODGEPOLE BLOWOUT INQUIRY

PHASE 1 REPORT - SUMMARY AND RECOMMENDATIONS

WITH RESPECT TO AN INQUIRY HELD
INTO THE BLOWOUT OF THE WELL, “AMOCO DOME
BRAZEAU RIVER 13-12-48-12”

DECEMBER 1984

LODGEPOLE BLOWOUT INQUIRY PANEL

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SUMMARY AND RECOMMENDATIONS

The report concerns

The summary and recommendations of the Inquiry Panel respecting the blowout of the well, “AMOCO DOME BRAZEAU RIVER 13-12-48-12,” which blew out of control on 17 October 1982.

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SUMMARY

INTRODUCTION

17 October 1982 will likely be a significant date in Alberta's history. It was on that day at 14:30 that the well, AMOCO DOME BRAZEAU RIVER 13-12-48-12 (13-12 well), located 20 kilometres (km) west of the small hamlet of Lodgepole, blew out of control. For over 2 months specialists fought to regain control of the well and were finally successful on 23 December 1982.

People residing near the blowout were significantly affected by events during the 67 days. At times, the odours were severe and people feared for their health and safety. Even people far removed from the area were subjected to the unpleasant odours, depending on atmospheric conditions.

The blowout will likely have a significant impact on the Alberta gas industry, particularly with respect to drilling sour gas wells.

A public inquiry was convened to learn what happened, why it happened, and how it might be avoided in the future. The Inquiry Panel's (Panel) views on these questions are provided in this summary.

WHAT HAPPENED AT LODGEPOLE?

In August 1982, Amoco Canada Petroleum Company Ltd. (Amoco) applied to the Energy Resources Conservation Board (ERCB) for a licence to drill a well to be located 20 km west of the hamlet of Lodgepole, Alberta. The well was spudded on 10 August 1982 and was drilled to about 3000 metres (m) without significant incident. Intermediate casing was then installed prior to drilling into the expected productive formation. On 15 October, the drilling crew began coring into the zone and the first two cores were obtained without apparent problems. On 16 October, the crew proceeded with core No. 3, but halted coring operations when evidence of fluid influx from the formation was detected.

For the next 16 hours, the crew fought to regain control of the well but finally, at 14:30 on 17 October, the well blew out of control. In spite of numerous measures to regain control, the sour gas blowout persisted for 67 days with control finally being regained on 23 December 1982.

THE INQUIRY

On 14 January 1983, the ERCB announced that an inquiry would be held to determine the facts surrounding the Lodgepole blowout. The inquiry was held in two phases and this report deals with Phase 1, the analysis, findings, and recommendations regarding the blowout itself.

IMPORTANT ISSUES

As a result of several public pre-inquiry meetings with participants, the Panel determined that the following were the most important issues to be addressed:

> What were the factors contributing to the Lodgepole blowout and what actions were taken to prevent it? Were these actions adequate?
>
> What significant factors contributed to regaining control of the well? Were control actions adequate?
>
> Was there a hazard to human health and, if so, was the effect measurable? What steps were taken to minimize the effect and were the steps adequate?
>
> Was there an impact on the environment and, if so, how serious was it? What steps were taken to reduce the impacts and were the steps adequate?
>
> Were ERCB and Government department regulations, policies, and procedures adequate? Were the responses to the emergency following the blowout adequate?

Additionally, the Panel decided it should examine, quite separately from the 13-12 incident, the more general question of whether further actions should be taken to minimize the possibility of future blowouts in Alberta. That assessment took place following the main inquiry and the Panel's conclusions were provided in its Phase 2 report issued in April 1984.

WHAT WENT WRONG AT THE 13-12 WELL?

The drilling plan for the 13-12 well included cutting cores in the productive formation. While cutting the third core on 16 October, reservoir fluids, including sour gas, unexpectedly entered the wellbore resulting in what the industry calls a "kick". Amoco was unsuccessful in controlling the kick and after a 16-hour battle, totally lost control of the well on 17 October.

Why did the kick occur? Unfortunately, it is not possible to be certain as to all of the developments that occurred on 16 and 17 October. Nevertheless, the Panel's reconstruction of those events leads it to conclude that the initial kick occurred primarily because drilling practices during the taking of cores No. 2 and 3 were deficient and, when combined with the marginally adequate mud density being used, this permitted the entry of reservoir fluids into the wellbore.

The Panel also has concluded that the kick was likely not controlled because

(a) the drilling crew did not immediately recognize the problem and therefore did not immediately apply and maintain standard kick-control procedures,

(b) several pieces of vital equipment did not function properly, including:

  (i) casing pressure instruments,
  (ii) the degasser,
  (iii) drill pipe, and
  (iv) travelling block hook latch, and

(c) supplies of mixed drilling mud were not adequate during the kick-control operations.

In summary, the Panel concludes that no single element in the chain of events was the sole cause of the blowout. The unexpected entry of reservoir fluids into the wellbore was probably due to a combination of Amoco not adhering to sound drilling practices and only marginally adequate mud density. If the degasser had operated effectively, the initial kick might have been circulated out of the system, and subsequent kicks would likely have been avoided. Even with the failure of the degasser, control might have been maintained if there had been sufficient and properly weighted mud on hand to pump into the well. Additionally, if the casing pressure instruments had been operational from the outset, the crew might have recognized the kick at an earlier stage and implemented standard kick-control procedures when fluid influx was still relatively small. If the decision had been made to use hydrogen-sulphide- (H_2S) resistant pipe for the full drill string, the pipe might not have parted and the succession of kicks might still have been successfully circulated out. And finally, if the travelling block hook latch had not failed, it may have been possible to retain control of the well by "top kill" methods.

Were Amoco's actions satisfactory respecting these various developments? Amoco indicated that its program was based, from the outset, on the possibility but not an expectation of encountering sour gas. The Panel is satisfied that Amoco applied reasonable judgement with respect to the selection of the Nabors rig, approving the degasser, and to a lesser degree, in selecting the type of drill pipe to drill the well, even though, with hindsight, the latter two turned out to be inadequate for the conditions that developed. On the other hand, the Panel believes Amoco's actions were deficient with respect to:

(a) drilling practices during coring operations (cores No. 2 and 3),

(b) implementation of standard kick-control procedures,

(c) ensuring adequate mixed drilling mud was available at all times, and

(d) maintaining equipment in satisfactory operating condition (casing pressure instruments).

It appears to the Panel that the fundamental problem was that Amoco did not apply the necessary degree of caution while carrying out operations in the critical zone. Amoco did not appear to be sufficiently aware of the potential for problems that could occur when coring into the porous zone and thus the need to be fully prepared in the event of a fluid influx. Consequently, when a kick developed, there were delays in responding to it. Then, when equipment problems occurred and supplies of mixed mud were inadequate, Amoco was forced into further delays of precious time in implementing kick-control actions.

In summary, it is clear to the Panel that the major area of deficiency relates to the "human factor" which was so extensively referred to during the Phase 2 portion of the inquiry.

The Panel has made a series of recommendations aimed at reducing the possibility of future blowouts. Several have already been implemented, or are being studied. Anyone interested in the detailed assessment of the cause of the blowout, or the Panel's specific recommendations, is invited to review section 5 of the full report.

REGAINING CONTROL OF THE 13-12 WELL

It required 67 days to regain control of the 13-12 well. Why did it take so long?

The Panel believes that several factors were instrumental in the delay:

1 The well was particularly difficult to tame.

The flow rate from the well was much higher than originally estimated. Also, the flow contained large volumes of condensate and a high percentage of H_2S, both of which became serious inhibiting factors to regaining control. Indeed, the Panel believes it would be difficult to find a more serious and difficult blowout to control.

2 Weather conditions were frequently unfavourable.

Because of the high flow rate from the well, and its high H_2S content, work on the well was possible only when there was sufficient wind to disperse the gas. Frequently, atmospheric conditions were relatively calm, and for more than 8 days out of the 26 days that the well was not on fire, weather conditions at the well site prevented the control crews from working.

3 Amoco's safety procedures and equipment, while appearing to be typical for the industry, were not adequate to cope with the magnitude and type of emissions from this particular well. As a result, a serious accident interrupted an operation that might have been successful with a less difficult well, and resulted in a further well-control delay of 37 days.

Initially, Amoco and the ERCB had concluded that only two well-control options were available: capping the well while it was not on fire, or drilling a relief well. Since the relief well would take up to 3 months to drill, with no assurance of success when completed, it was judged to be a last resort. After Amoco and the ERCB became aware of the damage to the casing bowl from the second fire and significant effects that the sour gas well emissions seemed to be having on the general public, consideration was given to a third control option, capping the well while it was on fire. Evidence at the inquiry indicated that this technique had been used only six times worldwide, and only on wells that were much smaller "blows" than the 13-12 well. While both Amoco and the ERCB recognized the serious risks inherent in this procedure, it was nevertheless selected because of the special circumstances. It eventually proved successful, but required another 21 days before it could be completed.

The difficulties encountered in regaining control of the 13-12 well, and the resulting impacts on the public, amply demonstrate the need to avoid such situations in the future. Once a well has blown out of control, the options available to the well-control crew are limited. One of the benefits from the 13-12 experience was to learn that such a difficult well could be brought under control while it was on fire.

HAZARD TO HUMAN HEALTH

How did the emissions from the well affect the health of people residing in nearby regions?

The Panel heard evidence from 30 local residents, members of the Pembina Area Sour Gas Exposures Committee (PASGEC) at the formal inquiry, and 11 residents at the informal session, describing how the blowout had affected the health of members of their families. These effects were said to include headache, eye irritation, upper respiratory tract symptoms such as sore throat, nasal irritation, and nosebleeds in children, and lower respiratory tract symptoms, including pain on deep inhalation and some shortness of breath. The Panel also heard evidence from the Edmonton Area Respiratory Patients. Several of the PASGEC witnesses also referred to a similarity in the symptoms of illnesses in both people and livestock.

Various interpretations were placed on these submissions. Some participants at the inquiry contended that the problems related to a "flu epidemic", others to psychologically induced reactions. Others claimed that the noxious gas was the cause.

Unfortunately, there was a lack of scientific data available for analysis. Considering the large amount of circumstantial evidence, however, the Panel is satisfied that the well emissions did lead to at least short-term health effects for a substantial number of people, particularly in the Lodgepole area. The anecdotal evidence also strongly suggests that some people, especially those having respiratory problems, are much more likely to suffer unfavourable effects from H_2S gas.

What steps were taken by Amoco and Government agencies to protect the health and safety of persons living in the local area?

Although it was not set out in a single document, a protection plan was put in place which provided for:

(a) the establishment of a set of H_2S exposure limits designed to safeguard human health,

(b) the monitoring of actual H_2S concentrations throughout the area where people were residing, and

(c) arrangements for people to leave the area whenever H_2S concentrations exceeded the exposure limits. Where evacuation was deemed not practical, such as in Drayton Valley, the plan called for ignition of the well if H_2S concentrations exceeded the prescribed limits.

Exposure Limits

The protection plan was designed to ensure that if an H_2S concentration of 15 parts per million (ppm) was reached in any area where people were residing, then they would leave the area. Additional standards were identified for persons described as "sensitive", which generally was taken to mean persons with respiratory problems, very young children, the elderly, and pregnant women. However, for various reasons, these additional standards, while acknowledged, were not actually applied.

The appropriateness of the H_2S exposure limits was extensively debated at the inquiry. Particular concern was expressed about the need for much stricter standards for those persons judged to be more susceptible to H_2S.

The Panel recognizes the concerns about the standards, particularly regarding more stringent standards for sensitive people, and has recommended that this matter be given further consideration by the Provincial Board of Health (PBOH).

Monitoring H_2S Concentrations

The air monitoring program to determine actual H_2S concentrations in the general Lodgepole area was under the direction of Alberta Environment (AE). Stationary air monitors were installed in the nearby communities of Cynthia, Lodgepole, and Drayton Valley, and at the Brazeau Dam. Five mobile air monitors, four of them operating 24 hours per day, were used to check rural areas. Under the plan, three of the mobile monitors followed the highest H_2S concentrations as the plume moved through the area.

The monitoring data gathered during the event shows that the dispersion of the gas cloud from the well was actually quite rapid, notwithstanding the large volumes of H_2S gas being emitted. For example, no concentrations in excess of 10 ppm were found at any residences located farther than 20 km from the well, and there were only a few instances inside that 20-km radius. The highest concentration recorded at Cynthia was 14 ppm, at Lodgepole 14.5 ppm, and 5 ppm at Drayton Valley, some 45 km from the well. The highest reading in Edmonton was 0.5 ppm.

Throughout the 26-day period that the well was not on fire, H_2S concentrations were generally low. For example, at Lodgepole, the concentrations were less than 1 ppm for 87 per cent of the recorded hours, while at Cynthia and Drayton Valley they were less than 1 ppm for about 95 and 96 per cent of the time, respectively. In Edmonton, though the odour was detected, the H_2S concentrations were actually less than 0.1 ppm for 93 per cent of the time.

Evacuation

There were six occasions during the 26-day period that the well was not burning when concentrations at local residences reached the evacuation level of 15 ppm. All of these cases were in rural areas. Where they occurred, the people were notified and they left the area on a temporary basis. Additionally, Amoco advised that it was prepared to pay the costs for people who wished to leave the area because of effects from the emissions. A total of 28 individuals plus 4 families left on the basis of the Amoco offer.

IMPACT ON THE ENVIRONMENT

How serious was the environmental impact from the well emissions?

During the 67 days the well was out of control, there were daily emissions to the atmosphere of 150 to 450 tonnes of sulphur and 300 to 1100 cubic metres (m^3) of condensate. For the 26 days the well was not on fire, the condensate fell on the area immediately surrounding the well site and had an impact that was initially like that of an oil spill. Subsequent fires caused the lease area to be extensively burned. While this destroyed vegetation over a large area, it reduced long-term condensate pollution problems. During the period the well was on fire, the sour gas and condensate was combusted in the extremely intense fire and the H_2S was converted to sulphur dioxide (SO_2).

Obviously, emissions of that magnitude are certain to have some environmental impacts. Several studies were made to evaluate the extent of the impacts and the results were submitted to the inquiry. An area of some 300 hectares (ha) surrounding the well was the most seriously affected. There were major impacts on vegetation and soils in that area and minor impacts on surface water, groundwater, benthic organisms, mammals, and birds. Some of these impacts were ameliorated by quick remedial action. Due to the presence of residual condensate on the vegetation outside the burned and cleared areas and in the ground right around the well, there will continue to be impacts near the well site for some years on trees, groundwater, and soil.

To overcome the major impacts in the vicinity of the well, a program of short-term remedial measures and longer-term reclamation has been established. The program is comprehensive and should permit successful rehabilitation of the impacted area.

Sulphur emitted from the well, primarily in a gaseous form, was eventually deposited in low concentrations on the ground over an area of hundreds to thousands of square kilometres. There is no evidence that these levels of sulphur deposition will have long-term harmful effects on soils, vegetation, or water bodies.

RESPONSES BY ERCB AND GOVERNMENT DEPARTMENTS

Were ERCB and government regulations fully complied with during both the drilling and control operations at the 13-12 well?

Were the responses by the ERCB and Government departments appropriate during the emergency especially in terms of protecting the public?

The Panel did not find any evidence that Amoco had, in any significant manner, contravened either ERCB or government regulations. However, it did find that those regulations and policies need strengthening in several areas as they relate to the drilling of critical sour wells.

The Panel has made specific recommendations in several sections of this report to achieve that objective.

The Panel concluded that the response by the ERCB and Government departments was generally adequate, although improvements could be achieved particularly in the co-ordination of emergency response activities. A glaring deficiency by all parties related to communication with the public and the media during the blowout period. It was generally conceded by participants that efforts in this respect had been unsatisfactory and that major improvements were needed. The Panel believes that many of the problems relating to the public, that occurred during the incident, were directly attributable to inadequate communication. The Panel has recommended that a specific communication program be developed so that, in the event of another incident, the public can be kept properly informed and can have its concerns more effectively addressed.

WHAT ABOUT THE FUTURE?

One of the objectives of the inquiry was to identify actions which might be taken to significantly reduce the possibility of a future "Lodgepole". In order to consider that question, the Panel arranged for a separate phase of the inquiry (Phase 2) to consider evidence from drilling industry experts on how blowouts might be reduced. That phase resulted in a substantial number of recommendations by participants, most of which the Panel endorsed in its Phase 2 report, and which the ERCB is pursuing in conjunction with industry. Several of those recommendations are already in effect, although some are on a preliminary or trial basis only.

In its two inquiry reports, the Panel has made many recommendations that relate to drilling, well control, and impacts on the public. The important question is whether those recommendations, if implemented, would significantly reduce the likelihood of future blowouts. To test that proposition the Panel has, in section 13 of the full report, reconstructed the 13-12 case, but has assumed that its various recommendations were in place and operating effectively prior to the licensing of the well.

From its test of this proposition, the Panel is reasonably certain the 13-12 blowout could have been avoided. Implementation of the Panel's recommendations can significantly reduce the number of blowouts in Alberta, provide some assistance in regaining control of any well where a blowout has occurred, and would play a major role in assisting the public during a blowout. Obviously, major attention should be directed to avoiding blowouts. To that end, the Panel's recommendations include changes in equipment, changes in procedure, and the strict observance of prescribed or accepted operating practices. Particular emphasis needs to be placed on the "human factor" which appears to be a root cause of blowouts. The Panel believes that an effective means of reducing the impact of human factor problems would be to require that operations in the critical zone be conducted in a very cautious and careful manner. To achieve that objective will require the commitment and direction of senior management of those companies drilling critical sour wells. The ERCB can assist by strengthening its inspection procedures and regulatory requirements.

CONCLUSION

The Panel's findings indicate that the 13-12 blowout could probably have been avoided, even allowing for equipment failures, if Amoco had followed a policy of cautious drilling in the critical zone and if Amoco had been better prepared to deal with unexpected developments. The public was understandably concerned, frightened, and angry about the blowout. Two workers lost their lives, and the public experienced widespread and unpleasant health effects. While the evidence suggests to the Panel that the actual long-term physical effects were relatively minor, the legacy of the Lodgepole blowout will permeate the Alberta scene for many years. This is a matter that will require special attention by industry, the ERCB, and Government departments. Special efforts must be made by all parties to avoid another occurrence, if at all possible, and to more effectively handle events should another major well blowout ever occur.

The Panel has made many recommendations that, if fully implemented, can significantly reduce the number of blowouts. Special emphasis has been placed on critical sour wells. Several of the recommendations relate to a review of drilling equipment, but the primary emphasis has been placed on the need to reduce blowouts caused by human error. The Panel has reviewed the inquiry reports issued earlier this year for the blowout at the SHELL ET AL UNIACKE G-72 well[1], off the east coast of Canada, and the loss of the Ocean Ranger[2] drilling rig. It also has reviewed the previous ERCB report on the blowout of the well, AMOCO PACIFIC BRAZR 7-10-48-12 (7-10 well), which occurred in the same area only 5 years prior to the 13-12 blowout. Each of these three reports indicates that a combination of equipment and human factor causes were responsible for the failures. In each case, the relevant inquiry panel, either directly or indirectly, indicated that the failure probably would not have occurred had appropriate practices been followed, notwithstanding the equipment problems. These conclusions are very similar to those for the 13-12 well.

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[1] Report of Investigation of Events Culminating in a Blowout of Gas and Condensate at Shell Et Al Uniacke G-72.

[2] Royal Commission on the Ocean Ranger Marine Disaster – Report One.

The question, then, is how can human factor problems be significantly reduced in drilling operations? The Panel believes that the most effective way would be to ensure that drilling personnel:

(a) are well trained,

(b) are at all times conscious of potential problems, and ready to deal with them,

(c) are properly supported by technical assistance,

(d) follow a sound and safe drilling plan, and

(e) proceed with operations in a cautious manner, particularly while operating in critical zones.

The primary responsibility for ensuring that these objectives are achieved lies with industry and, in particular, with the company that has been issued a licence to drill. Several of the Panel's recommendations address these issues.

The Panel also believes that the ERCB has a responsibility to test whether these objectives are being achieved, and in that regard believes that the ERCB inspection system should be carefully reviewed to determine how it can be strengthened to minimize human factor problems.

RECOMMENDATIONS

THE CAUSE OF THE BLOWOUT AND THE ADEQUACY OF AMOCO'S ACTIONS

1 The following types of equipment should be examined for design, capacity, and operational problems to ensure that they are adequate for worst-case conditions:

   (a) degasser,
   (b) casing pressure instruments,
   (c) travelling block hook latch,
   (d) kelly hose,
   (e) blowout preventers (BOP), and
   (f) equipment for anchoring drill pipe.

2 The BPRC should examine the impact of H_2S, and how to avoid those impacts on:

   (a) drill pipe,
   (b) external BOP components, and
   (c) BOP master controls.

3 The industry and ERCB should take any action necessary to ensure that drilling operations are carried out in a cautious manner, particularly in the critical zone of critical sour wells. Special procedures should be developed, documented, and used for operations in the critical zone. These would include detailed instructions respecting tripping in, tripping out, coring, testing, and other operations where particular care is required.

4 Standard kick-control procedures should be reviewed to determine whether they allow for situations where equipment failures or other unexpected events occur during control operations.

5 The adequacy of the current training programs for drilling personnel should be reviewed and, in particular, consideration should be given to ensuring that they are effective in ensuring crew familiarity with kick recognition and control.

6 Consideration should be given to the need to have special expertise available while operations are being conducted in the critical zone of critical sour wells.

7 The ERCB should review its inspection system and, in particular, it should conduct special inspections of critical sour wells immediately prior to entry of the critical zone and while drilling in it, to ensure that operations are being conducted in a cautious manner and consistent with proper procedures.

8 Mud system design and operation should be reviewed respecting density, system capacity, back-up supply, scavengers, and impact of H_2S on mud and the ability to pretreat and recondition it.

9 Occupational Health and Safety Division of Workers' Health, Safety and Compensation (OH&S) should consider amending its regulations to ensure that breathing apparatuses are available for all individuals that may be at a rig, including extra people called in for an emergency.

WELL-CONTROL ACTIVITIES AND THE ADEQUACY OF ACTIONS BY AMOCO AND OTHERS

1 The ERCB and the involved operator should make a serious effort at the outset of any blowout to ensure that the flow rate and other characteristics are estimated as accurately as possible, and that the estimates and the expected weather conditions are properly recognized in planning for control of the well.

2 The ERCB should formalize, to a greater extent, its involvement in decisions related to intentionally igniting blowouts and the possible drilling of relief wells. A process should be developed that would ensure that public concerns are properly considered in making these decisions, and the reasons for the decisions are communicated to the public.

3 OH&S should give consideration to the establishment of a committee to be concerned with protecting workers in toxic gas environments such as would result from episodes like the 13-12 blowout. Such a committee might be composed of experts on safety and rescue drawn from OH&S, the petroleum industry, the ERCB, and the Calgary and Edmonton fire departments. These individuals, or a team which they could assemble, could be readily available to act as advisers or participants in the management of the safety aspects of particularly dangerous situations in the petroleum industry. With respect to the prevention of serious accidents, they could assist in reviewing current and future safety and rescue practices and safety educational programs.

4 OH&S should give consideration to the development of an adequate, possibly compulsory, training program for workers who might encounter H_2S or other toxic gases in substantial amounts. This training would be needed prior to their involvement at a well site or other potentially dangerous locations. This training should emphasize practical matters such as familiarization with and the wearing of a self-contained breathing apparatus. Through such a program, workers who are physically or psychologically unsuitable for work in such hazardous environments, or while wearing masks, would likely be identified.

5 The ERCB should investigate the availability and limitations of blowout insurance. The Panel understands that the matter of insurance is being looked at by the ERCB as a result of the Phase 2 report.

6 The ERCB should consider how the experience and expertise needed to control a blowout would always be available when required, even by a small organization.

7 OH&S should pursue the development of clearly distinguishable names for all types of masks to be used in the presence of various concentrations of H_2S.

8 Consideration should be given by industry and the ERCB to the development of a workshop or seminar to consider technical matters related to the control of wild wells.

HAZARD TO HUMAN HEALTH

1 The Provincial Board of Health (PBOH) should reconsider its H_2S exposure limits in light of the Lodgepole evidence and, in particular, for "sensitive individuals".

2 Information should be obtained by the PBOH on the biological effects of extended intermittent and continuous exposure to moderate and low-level concentrations of H_2S, such as were experienced by residents and animals during the Lodgepole blowout. This could be obtained by modern research techniques.

3 AE, the ERCB, and representatives from industry and the public should develop a comprehensive centrally dispatched air monitoring plan that could be implemented immediately when needed.

4 AE and the ERCB should arrange for a comparison and analysis of actual H_2S concentrations obtained by monitors and the predicted concentrations from dispersion modelling, with the objective of improving the latter capability.

5 Further consideration should be given by the PBOH and other medical bodies to whether useful information could be obtained from a review of actual medical experience during the blowout, and to consider whether better measures can be implemented to determine the effects of emissions from other blowouts which may occur in the future.

6 Methods of providing remote rural residents with Drager units and possibly crush ampoules, and training in their use, should be addressed in site-specific emergency response plans.

7 The ERCB should attempt to identify all of the gaseous contaminants, in addition to H_2S and SO_2, which could be produced by a sour gas well, since other components could also have biological significance. This type of physical chemical analysis could be carried out on material safely obtained from an existing well or wells.

IMPACT ON THE ENVIRONMENT

1 AE and other appropriate Government departments should establish a protocol for improved sampling and analysis of soil and vegetation that would provide a means of evaluating impacts of sour gas releases on soils and vegetation if a blowout occurs in future.

2 Alberta Forest Service (AFS) should co-ordinate long-term monitoring of impacts on the biosphere in the "on-site and immediate" area of the 13-12 well, plus adjoining areas of the blowout, as defined in the full report.

3 Alberta Agriculture (AA) should develop a protocol to enable the gathering of timely and relevant data on agricultural activities if another serious sour gas release occurs.

4 AA should consider conducting an on-going examination of livestock in the general blowout area to determine if effects of long-term exposure to H_2S can be found.

5 The ERCB, the industry, and appropriate Government departments should consider ways of dealing with concerns of the public respecting monetary impacts on the public resulting from sour gas blowouts.

6 The ERCB and AE should arrange a symposium to hear expert views on plume modelling/plume impingement and sulphation ground sampling analysis techniques.

COMMUNICATION AND CO-ORDINATION

1 A model communication program, along the lines suggested in section 9.4 of the full report, should be developed by appropriate Government departments and agencies with input from the public and industry.

2 The "Peacetime Emergency Operations Plan For a Sour Gas Release", recently issued by Alberta Disaster Services (ADS), should be reviewed in light of the Panel's recommendations.

3 The establishment of a "command post" organizational structure should be confirmed and implemented for all significant blowouts.

ADEQUACY OF ERCB'S RESPONSES FOLLOWING THE BLOWOUT, AND ITS REGULATIONS, POLICY, AND PROCEDURE

1 The ERCB, with appropriate input from industry, the public, and other Government departments, should identify wells which are "critical" in terms of avoiding possible blowouts and establish special conditions that must be satisfied by an operator before these wells can be drilled. The ERCB should advise other government agencies of all licences issued for critical wells.

2 The ERCB and other involved Government departments should establish a plan for their involvement in future emergencies such as the 13-12 well. The plan should include, among other matters, details regarding the responsibilities of various parties, standards for notification and evacuation, and plans for communication with the public and the media. Care should be taken that appropriate municipal officials are aware of the plan.

3 Special efforts should be made to more accurately estimate the potential H_2S release rate for a critical sour well.

ADEQUACY OF THE GOVERNMENT DEPARTMENTS' RESPONSES FOLLOWING THE BLOWOUT, AND THEIR REGULATIONS, POLICY, AND PROCEDURE

1 A government emergency response plan should be put in place for dealing with sour gas releases in the province. Such a plan has been prepared by ADS on an interim basis and will be reviewed in light of this report, comments from the public, and other involved parties. It should be maintained on a current basis. The final plan should address all significant matters relevant to serious sour gas releases and in particular the following:

(a) the responsibilities and authorities of various departments and agencies,

(b) the need for a control and communication centre,

(c) procedures to obtain the best possible estimates of gas flow and composition data,

(d) the availability of suitable equipment for monitoring,

(e) ways in which to make communications with the public and media more effective,

(f) standards, notification, and evacuation criteria and procedures,

(g) the decision process with respect to possible ignition of wild wells,

(h) the collection of data for health research purposes, and

(i) impact of sour gas on animals and crops and ways of better advising rural people respecting these matters.

The public should have the opportunity for input to the plan and should be made aware of its existence when it is in place.

2 OH&S should review its procedures and regulations respecting the suitability and number of breathing apparatuses, the training of workers in their use, review procedures for dealing with workers' health and safety matters for sour wells, and develop a program of direct involvement by senior OH&S staff to be implemented in the event of a blowout. This might be done through a series of workshops.

3 The PBOH should review existing H_2S exposure standards, particularly as they relate to sensitive individuals, in light of experience gained from the Lodgepole blowout.

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